

WHAT IS CLAIMED IS:

1. A plasma processing apparatus comprising a first chamber provided with a plasma inducing device designed to produce a plasma in said first chamber, and a second chamber into which plasma so produced can diffuse to act upon a workpiece being processed, and a magnetic field production device positioned relative to at least the first of said two chambers and constructed to cause attenuation of the ions which diffuse into the second chamber and approach the workpiece, by directing a proportion of the ions to a loss surface of either chamber.
2. Apparatus according to claim 1, wherein the magnetic field production device comprises permanent magnets or electromagnets installed around the side wall of the first chamber.
3. Apparatus according to claim 1, wherein the magnetic field production device around the first chamber is a solenoid whose output can be varied.
4. Apparatus according to claim 1 and incorporating an additional plasma inducing device at the upper region of the second chamber.
5. Apparatus according to claim 4, wherein permanent magnets, electromagnets or a solenoid are installed also around said additional plasma inducing device at the upper region of the second chamber, as a further magnetic field production device.

6. Apparatus according to claim 1, wherein the magnetic field production device comprises a magnetic structure formed at the junction of the two chambers to create a dipole magnetic field there.

7. Apparatus according to claim 1, and incorporating a ring gas feed within the second chamber, below the junction point of the two chambers, in addition to a gas feed inlet to the top of the first chamber.

8. Apparatus according to claim 1, wherein a solenoid device whose output can be varied is provided for the second chamber at a position to create a magnetic field inside the second chamber at the level of the workpiece to steer ions towards the workpiece.

9. Apparatus according to claim 1, wherein the second chamber is provided with a magnetic bucket arrangement created by an array of magnets around the chamber wall.

10. Apparatus according to claim 1, wherein the first chamber geometry is formed as a cylinder, a stepped cylinder, a cone, a truncated cone, or a hemisphere, or a combination of these geometries.

11. Apparatus according to claim 1, wherein the first chamber is of annular form and the annular magnetic field production device comprises separate permanent magnets, electromagnets or solenoids located both within and around said annulus.

12. Apparatus according to claim 11, wherein further annular forms of a first chamber with pairs of attenuation magnetic field production devices and with plasma inducing devices are positioned concentrically of one another.

13. Apparatus according to claim 1, wherein the first chamber is formed of two or more differing-diameter cylindrical dielectric sections, one above the other, each such section being provided with its own plasma inducing device.

14. A plasma processing apparatus comprising a first chamber provided with a plasma inducing device designed to produce a plasma in said first chamber, and a second chamber into which plasma so produced can diffuse to act upon a workpiece being processed, wherein the first chamber is formed of two or more differing-diameter cylindrical dielectric sections, one above the other, each such section being provided with its own plasma inducing device.

15. Apparatus according to claim 13, wherein the portions joining the individual sections of said first chamber are formed of metallic or dielectric material.

16. Apparatus according to claim 13, wherein the portions joining the individual sections of said first chamber are positioned perpendicular to or angled to said sections.

17. Apparatus according to claim 13, wherein the multi-section first chamber has a magnetic field production device associated with more than one of said

sections, each constructed to cause attenuation of the flux of the ions which diffuse into the second chamber and approach the workpiece.

18. Apparatus according to claim 14, wherein the portions joining the individual sections of said first chamber are formed of metallic or dielectric material.

19. Apparatus according to claim 14, wherein the portions joining the individual sections of said first chamber are positioned perpendicular to or angled to said sections.

20. Apparatus according to claim 14, wherein the multi-section first chamber has a magnetic field production device associated with more than one of said sections, each constructed to cause attenuation of the flux of the ions which diffuse into the second chamber and approach the workpiece.

21. Apparatus according to claim 1, wherein said first chamber incorporates a dielectric plasma tube formed from aluminium nitride or silicon carbide or other dielectric material having a thermal conductivity sufficiently greater than aluminium oxide to allow high power operation without failure-inducing high thermal gradients arising in the dielectric material.

22. Apparatus according to claim 1, wherein a plurality of said first chambers are provided across the top of the second chamber.

23. A plasma processing apparatus comprising a first chamber provided with a plasma inducing device designed to produce a plasma in said first chamber, and a second chamber into which plasma so produced can diffuse to act upon a workpiece being processed, wherein said first chamber incorporates a dielectric plasma tube formed from aluminium nitride or silicon carbide or other dielectric material having a thermal conductivity sufficiently greater than aluminium oxide to allow high power operation without failure-inducing high thermal gradients arising in the dielectric material.

24. A method of controlling the transmission of a plasma to a workpiece, wherein plasma is created in a first chamber provided by a plasma inducing device, and is allowed to diffuse into a second chamber to act upon a workpiece being processed, and an attenuation magnetic field production device positioned relative to at least the first of said two chambers is operated in a manner to cause attenuation of the ions which diffuse into the second chamber and approach the workpiece, by directing a proportion of the ions to a loss surface of either chamber.

25. A method according to claim 24, wherein said attenuation magnetic field is produced by permanent magnets, electromagnets, or a solenoid whose output can be varied, positioned around the side wall of the first chamber.

26. A method according to claim 24, wherein plasma is also created at the upper region of the second chamber by an additional plasma inducing device.

27. A method according to claim 26, wherein an attenuation magnetic field is additionally produced by permanent magnets, electromagnets, or a solenoid located around said additional plasma inducing device at the upper region of the second chamber, as a further magnetic field production device, to cause attenuation of the ions which diffuse further into the second chamber.

28. A method according to claim 24, wherein said attenuation magnetic field is produced by a magnetic structure formed at the junction of the two chambers to create a dipole magnetic field there.

29. A method according to claim 24, wherein gas is fed into a ring gas feed within the second chamber, below the junction point of the two chambers, in addition to gas fed through a gas feed inlet to the top of the first chamber.

30. A method according to claim 29, wherein different gases are fed into said gas feed inlet and said ring gas feed.

31. A method according to claim 29, wherein the inlet gas flows to the gas feed inlet and the ring gas feed are controlled by separate mass flow controllers.

31. A method according to claim 29, wherein the process chamber pressure is set to different levels for each of different processing steps.

33. A method according to claim 24, wherein the first chamber is constructed from two or more differing-diameter cylindrical dielectric sections and RF power is

coupled into the plasma created in the first chamber by two or more separate antennae, each located around the respective cylindrical sections.

34. A method according to claim 33, wherein the relative power levels to the two or more antennae are adjusted to different values depending upon whether an etch step or a deposition step in a switched process is in progress.

35. A method according to claim 24, wherein the plasma inducing device is operated so as to pulse the plasma on and off during operation of the process.

36. A method according to claim 24, wherein magnetic confinement is provided in the second chamber by means of a magnetic bucket arrangement created by an array of magnets around the chamber wall.

37. A method according to claim 24, wherein the field strength of any one or more electromagnets employed to create an attenuation magnetic field is varied as a function of time.